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M. P. Shepard and K. V. Aro

(This report also appeared as International North Pacific Fisheries Commission Document No. 1452)

Pacific Biological Station, Nanaimo, B.C.

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RECENT TRENDS IN CANADIAN PACIFIC SALMON STOCKS

INPFC Doc. 997 (Canada) provided information on changes in fisheries and in condition of British Columbia salmon stocks up to 1966. INPFC Doc. 1349 (Canada) provided information for chum salmon up to 1970. The purpose of the present document is to provide comparable information on all British Columbia stocks up through 1970.

Figures 1 to 3 illustrate trends in landings (on a logarithmic scale) from 1945 through 1970 (recent catch data are listed in Table 1). Regression lines for 1945 through 1966 prepared for INPFC Doc. 997 are included. Average catches for 1967 through 1970 are shown by dotted lines. The average total salmon catch (Fig. 1) for 1967 through 1970 was substantially above that which would have been expected if the 1945 through 1966 trend had continued. This upward turn in total landings reflects the fact that catches of chums (Fig. 2), sockeye and chinook (Fig. 3) were all higher during 1967-70 than in the 10 previous years. Catches of pinks and coho during 1967 through 1970 were only slightly below projections of the 1945 through 1966 upward sloping trend lines, and were very close to the average of the overall 1945 through 1970 period. Thus, in general, British Columbia salmon are showing gratifying increases over the rather low levels of the early 1960's.

The increased yields follow a period of increasingly stringent restrictions of commercial fishing for most species. For example, as shown in Fig. 16, recent increases in chum catches in southern British Columbia follow a period when commercial catches were reduced by regulation almost to zero in order to increase spawning escapements.

In the following section detailed consideration is given to recent trends in some of the more important British Columbia salmon stocks.

FRASER RIVER SOCKEYE

INPFC Doc. 997 reviewed trends in the Fraser River sockeye stocks from 1939 through 1966 by plotting catches and escapements grouped by sequences of 4 years. The data showed a declining trend in catch from 1951-54 through 1963-66, with escapement levels being maintained at a nearly constant level. Figure 4 provides similar data for 1939 through 1966 except that catches in Johnstone Strait and in the troll fishery off northern Vancouver Island (predominantly sockeye bound for the Fraser) have been added to catches in all years (in INPFC Doc. 997, figures for Johnstone Strait only had been added for 1958 but not other years). In the new figure information for 1967 through 1970 has also been added. Figures 6 to 8 provide escapement data for individual Fraser systems paralleling Fig. 6 to 8 of INPFC Doc. 997. Figure 4 shows that, following two 4-year periods of high catches in 1951 to 1954 and 1955 to 1958, catches during the following two periods declined drastically but recovered during the most recent 4-year period to approximately 80% of the former level. The escapement during successive four year periods has been relatively constant in recent years. Because the stocks contributing to the runs vary from year to year within each 4-year period it is difficult to interpret the relation between escapement and return from the data shown in Fig. 4. Figure 5 shows catches for each "line" within the four-year cycles. Table 4 gives escapement data for recent years for each major system within the Fraser. Figure 5 and Table 4 indicate that the large catches of the 1951-54 and 1955-58 periods were dependent largely on bumper runs in the 1902 line to Shuswap Lake. A severe and unexplained drop in production from Shuswap occurred in 1962 and 1966. The catch in 1970 was only slightly better - still less than half the average of the 5 cycles preceding 1962. In contrast to production in the 1902 line, yields from the 1903 line in the Shuswap system have strengthened markedly. The 1967 Shuswap escapement jumped to over 800,000 from an average of under 100,000 and the total catch in 1967 jumped to the highest level for the 1903 line since the Hell's Gate slide of 1913.[1] Both the 1900 and 1901 lines also have shown increases in the last cycle, but not dramatic ones. Overall, then in the past 4 years sockeye of the Fraser River system have consistently provided higher catches than in the parent generations.

The relationship between escapement and return for each of the 4 lines are shown in Fig. 9 through 12. Points for the recent 4 years are indicated by triangles. The trend lines are the same as those shown in INPFC Doc. 997. In the 1901 line (Fig. 9), the return for the 1965 brood year was considerably above the trend line, but considering the range of scatter of points does not deviate greatly from the approximate relationship suggested by the trend line. The most recent point for the 1902 line (Fig. 10 - brood year 1966), like its immediate predecessor, falls well below the trend line, reflecting the continuing failure of the Shuswap Lake run to produce at the peak levels of the 1950's. The 1970 escapement for this line was about the same as in the parent year 1966, (and substantially less than in 1958). Returns in 1974 will be watched closely as an indicator of the productive capacity of the Shuswap Lake sockeye stock in

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[1]This line continues to produce well - 1971 catches in the Fraser Convention Area will exceed those of 1967.

the 1902 line. The most recent point for the 1903 line provides data for returns at an escapement level almost twice as great as any during the 56 year period for which estimates are available (Fig. 11). The surplus production from the 1963 brood over that required to replace the parent escapement was far greater than for any other brood year. Thus provision of increased escapement in this cycle resulted in a substantial increase in yield. As mentioned earlier a significant part of the increased production in 1967 came from the Shuswap Lake stock, a stock whose component in the preceding line has been performing at disappointing levels. Returns from both lines will be watched with interest over the next four years. These returns should shed light on the question of whether or not a major producing system such as Shuswap can provide large runs in more than one year within each four-year cycle.

In the 1904 line (Fig. 12), the most recent point (for the 1964 brood year) lies well above the trend line at a relatively low escapement level (around 0.4 million). Just as for the 1900 line, however, considering the range of scatter of the data, information for the 1964 brood year does not conflict seriously with that for preceeding brood years.

Figure 13 provides information on returns for different escapement levels for Fraser sockeye grouped by four-year intervals. The points for 1963-66 lie just slightly above the long term trend line developed in INPFC Doc. 997.

RIVERS INLET SOCKEYE

INPFC Doc. 997 noted that from 1911 to 1965 there had been a statistically significant decline in catches of sockeye salmon in Rivers Inlet, Canada's third largest sockeye producing system. Running counter to this trend, catches during 1966-70 (Fig. 14) showed a marked increase, due mainly to the very large catch of 2.7 million sockeye in 1968 (Table 5). The catch in 1970 was the lowest on record due to a strict closure imposed to provide spawning escapement.

SKEENA RIVER SOCKEYE

Tables 6 to 8 provide information to update Tables 7 to 9 of INPFC Doc. 997 and Fig. 15 updates Fig. 15 of INPFC Doc. 997. For the most recent 4 brood years (1962-1965), two points relating escapement and resultant return fell above the trend line and two fell below. The return from the largest spawning during the recent period (848,000) resulted in a very low return of only about 695,000 sockeye (Table 7 and Fig. 15). The average annual number of spawners in minor sockeye areas of the Skeena during 1966-70 were the lowest since estimates began in 1944. Despite the low return from the 1964 brood, the overall yield of the Skeena for the four most recent brood years has been most encouraging, approximating 1.4 million sockeye, and continuing an increasing trend in average return following a disastrous low during the 1950-53 brood years when the runs in two succeeding years 1951 and 1952 were decimated by a slide in the Babine River (Table 7).

Over the next few years production levels and management procedures are likely to change markedly on the Skeena River. Large spawning channels have been constructed on the two main tributaries to Babine Lake - (Fulton River and Pinkut Creek) which will accommodate approximately 225,000 more spawners than the natural rivers did and which should provide substantial increases in returning runs (hopefully in the order of 1 million sockeye). The channels have been under construction since 1965 and were seeded to near capacity for the first time in 1971. Substantial returns from the channels should begin within the next three years, with those in 1975 and 1976 showing the full effects of the channel contributions.

PINK SALMON OF SOUTHERN BRITISH COLUMBIA AND NORTHERN WASHINGTON

INPFC Doc. 997 noted that in 1957 and 1959 catches of pink salmon originating in the Fraser and adjacent river systems in Canada and the United States fell to about half of the average for the previous 5 odd-year cycles and in 1961 and 1965 to about one ninth. In 1963, an abundant run to Puget Sound boosted the yield to near the pre-1957 level. Table 9 presents data for 1967 and 1969 (pink salmon are virtually absent from the area in even-numbered years). In 1967, the Fraser run was the best in 10 years, and the overall southern British Columbia-Washington catch of around 8 million was again close to the pre-1957 levels. In 1969 all southern pink stocks fared badly and the catch dropped to below 2 million. Stocks in Canadian streams adjacent to the Fraser were specially hard hit, with escapement dropping to a few tens of thousands compared to over 1 million in 1963. Runs to Puget Sound were also weak. Preliminary returns in 1971 indicate an improvement in the runs to all areas over those in 1969.

PINK SALMON OF THE CENTRAL COAST OF BRITISH COLUMBIA

Runs of pink salmon in central British Columbia in odd-numbered years (Areas 5-10, 30 in Table 10) were very weak in 1967 and 1969, and fisheries were severely restricted to prevent virtual annihilation of spawning stocks. Even with such severe restrictions, escapements were still well below levels which had produced good odd-year returns in 1965 and earlier years (see Table 11 in INPFC Doc. 997).

In recent years, the even-year pink runs in the area have been stronger than those in the odd-numbered years. The run in 1968 was good, the second largest in the history of the area and 1970 catches, though below those of 1968, were still above the average.

CHUM SALMON IN SOUTHERN BRITISH COLUMBIA

As shown in Fig. 2, British Columbia chum salmon catches increased markedly during 1968-70. In southern British Columbia, the province's most important chum area, the recent recovery followed a period when the commercial fishery was almost completely closed to fishing for four consecutive years (1965-67 - Fig. 16); during this period, catches were cut almost to zero to provide very modest spawning escapements. As outlined in INPFC Doc. 1349 submitted at the 1970 Annual Meeting, it is doubtful if the recent increases in chum stocks could have occurred if the severe closures had not been applied; increased exploitation in the critical period of low stock levels would have undoubtedly delayed the recovery of the stocks. Tables 11 and 12 and Fig. 17 update information contained in Tables 12 and 13 and Fig. 17 of INPFC Doc. 997.

Table 1. Canadian landings of each species of salmon, 1967 - 70 (1,000's of pounds). Based mainly on round weight, but chinook and coho figures are largely dressed weight, heads on. Source: British Columbia catch statistics. For earlier years see INPFC Bulletin 9, p. 7 and INPFC Doc. 997, Table 1.

Year	Sockeye	Chinook	Coho	Pink	Chum	Total[a]
1967	36,814	13,789	20,399	49,785	12,136	133,176
1968	41,206	13,611	29,994	54,827	36,496	176,356
1969	23,977	12,599	15,710	13,218	13,389	79,036
1970	24,789	12,989	27,498	52,165	36,920	154,486

[a] Includes a small quantity of steelhead trout.

Table 2. Commercial catches of sockeye in the IPSFC Convention Area, in Areas 12 to 16, and in the troll fishery off the west coast of Vancouver Island; subsistence catches along the Fraser River; and estimated escapements of Fraser River sockeye (1,000's of fish). Source: Annual Reports of the IPSFC and British Columbia catch statistics.

	Commercial catch			Subsistence catch	Total catch	Escapement			Total (excluding jacks)
	Convention Area[a]	Area 12 to 16	Troll West Coast Vancouver Island[b]			Jacks	Large	Total	
1967	3,963	1,356	84	107	5,510	22	1,333	1,355	6,843
1968	1,806	465	61	124	2,456	34	595	629	3,051
1969	3,262	548	107	159	4,076	84	936	1,020	5,012
1970	2,892	1,042	152	151	4,237	83	1,865	1,948	6,102
Total	11,923	3,411	404	541	16,279	223	4,729	4,952	21,008

[a] Catch by Canada and the United States in Convention waters only.

[b] Troll catch in Area 24 north of Convention waters and in Areas 25, 26 and 27.

Table 3. Sockeye escapements (excluding jacks) to Fraser tributaries 1960 - 70, and averages for each line starting with 1938 in the 1902 line (1000's of fish). Source: Annual Reports of the IPSFC. For earlier years see INPFC Bulletin 9, p. 100-101.

	1901 line					1902 line					1903 line				1904 line				
	1961	1965	1969	Av.	%	1962	1966	1970	Ave.	%	1963	1967	Ave.	%	1960	1964	1968	Ave.	%
Lower Fraser	25.8	9.7	31.6	22.4	2.5	44.2	38.6	20.9	43.6	1.8	33.3	44.5	52.7	9.2	42.6	25.5	43.9	47.7	7.4
Harrison	47.4	26.8	74.0	40.4	4.5	24.6	52.5	23.3	46.1	1.9	36.7	43.1	25.5	4.4	29.3	7.4	10.3	30.4	4.7
Lillooet	31.7	8.2	36.4	41.6	4.6	26.4	20.1	30.7	44.7	1.8	48.9	39.9	40.3	7.0	35.9	48.9	58.1	50.4	7.9
Shuswap	5.8	10.1	16.6	9.6	1.1	1202.7	1311.7	1529.2	2047.0	83.4	228.1	858.3	96.6	16.8	6.1	4.4	8.0	8.8	1.4
N. Thompson	7.8	6.7	5.6	5.6	0.6	7.7	6.3	4.7	6.2	0.3	9.3	2.2	6.2	1.1	5.5	5.7	11.9	8.9	1.4
Seton-Anderson	0.3	2.6	1.7	0.7	0.1	12.1	31.4	4.0	7.0	0.3	6.1	7.6	1.9	0.3	5.4	19.4	10.1	6.4	1.0
Chilcotin	39.2	35.3	70.9	127.6	14.1	78.4	210.0	135.4	88.7	3.6	1029.9	180.4	247.1	43.0	423.2	238.7	413.9	439.1	68.5
Quesnel	302.3	364.6	279.0	172.4	19.1	1.1	1.8	1.4	0.9	<0.1	t	0.1	<0.1	<0.1	0.4	19.5	0.7	2.6	0.4
Nechako	83.3	55.2	85.8	70.9	7.8	126.9	103.3	50.5	123.3	5.0	150.4	102.7	69.0	12.0	40.6	32.7	32.6	26.2	4.1
Early Stuart	201.0	23.0	125.5	170.5	18.9	25.4	10.8	34.4	27.8	1.1	4.6	21.0	13.6	2.4	14.4	2.4	1.5	10.7	1.7
Late Stuart	410.9	214.9	204.9	234.4	25.9	44.1	8.7	14.9	12.4	0.5	3.2	1.6	2.6	0.5	2.4	1.8	0.4	0.7	0.1
Bowron	7.5	2.7	3.9	8.4	0.9	6.3	2.5	1.3	7.7	0.3	25.1	31.7	18.7	3.3	7.6	1.5	3.6	8.7	1.4
Total escapement	1163.0	759.8	935.9	904.5	100.1	1599.9	1797.7	1865.3	2455.4	100.0	1575.6	1333.5	574.2	100.0	613.4	407.9	595.4	640.6	100.0

Table 4. Sockeye escapements (not including jacks) to different tributaries of the Fraser River grouped by four year periods for 1939 to 1970. Source: Annual Reports of the IPSFC.

	1939-1942	1943-1946	1947-1950	1951-1954	1955-1958	1959-1962	1963-1966	1967-1970
Cultus	199	64	60	64	73	106	51	78
Pitt	16	63	197	128	76	71	56	62
Harrison River	64	33	78	93	27	97	72	54
Harrison Lake[a]	60	77	85	92	93	41	51	97
Lillooet	171	264	302	136	95	120	134	165
Early Shuswap[b]	3	3	37	64	104	119	113	43
Late Shuswap[c]	2219	2401	1475	2215	3344[d]	1283	1441	2369
North Thompson	14	11	31	43	33	31	28	24
Seton-Anderson	0	0	0	10	15	19	60	23
Chilcotin	616	592	800	831	1041	1020	1514	801
Quesnel	1	3	21	108	231	304	368	281
Nechako	58	280	351	370	306	333	341	272
Early Stuart	15	39	680	279	297	243	41	182
Late Stuart	6	25	136	362	558	438	229	222
Bowron	10	19	88	64	43	51	32	41
Total	3451	3874	4342	4859	6335	4275	4530	4715

[a] Includes Weaver Creek (= Morris Creek) as well as streams directly tributary to Harrison Lake.

[b] Includes runs which spawn in August and September.

[c] Includes runs which spawn in October and November.

[d] Includes 1,003,000 sockeye diverted from Adams River into Shuswap Lake in 1958.

Table 5. Rivers Inlet (Area 9) sockeye catches 1966 - 70 (1,000's of fish). Source: British Columbia catch statistics.

Year	Catch
1967	1107
1968	2715
1969	734
1970	19

Table 6. Estimated catches and escapements of sockeye salmon bound for the Skeena River, 1967 - 70 (1,000's of fish). Note: In some years important numbers of Skeena sockeye are caught in Alaskan fisheries. These are not included in this table.

Year	Catches				Escapement			Total stock (excluding jacks)
	Commercial		Subsistence	Total	Jacks[b]	Large	Total	
	Area 4	Areas 3X,3Y[a]						
1967	1044	313	39	1396	29	628	657	2025
1968	781	144	43	968	53	577	630	1545
1969	540	68	38	645	154	656	810	1301
1970	546	46	50	642	166	677	843	1319

[a] 4_2 and 5_2 fish only.

[b] Includes jacks (3rd-year sockeye) in the Babine system only.

Table 7. Sockeye spawners of life-history types 4_2 and 5_2 in the Skeena River system, and the 4_2 and 5_2 stock (catch plus escapement) produced by each spawning (1,000's of fish). Information compiled by I. S. Todd.

	Spawners	Resulting stock			
		4_2	5_2	Total	4 year average
1950	393	521	165	686	
1951	176[a]	52	75	126	740
1952	237[a]	482	227	710	
1953	700	560	879	1,439	
1954	511	683	778	1,461	
1955	87	240	134	374	1,188
1956	370	352	356	709	
1957	448	1,569	640	2,209	
1958	819	509	164	673	
1959	799	611	1,185	1,796	1,097
1960	273	464	303	767	
1961	936	663	490	1,152	
1962	558	554	988	1,542	
1963	597	972	1,278	2,250	1,409
1964	848	206	489	695	
1965	619	755	393	1,148	
1966	397	869			

[a]Estimate is for "effective spawners", corrected to account for the effects of the Babine River slide which blocked the river that year.

Table 8. Average of annual estimates of spawning stocks in the minor sockeye areas of the Skeena system (1,000's of fish). Some of these runs contain fish mainly of age 6_3, which are excluded from Table 7.

Period	Spawners
1967 - 70	32

Table 9. Commercial catches and escapements of pink salmon (1,000's of fish) in the IPSFC Convention Area and escapements to streams adjacent to the Convention Area. Source: Annual Reports of the IPSFC.

	Catches			Escapements		
	Canada	USA	Total	Fraser	Other Canadian	USA
1967	4,157	3,827	7,984	1,831	75	726
1969	862	946	1,807	1,529	63	340

Table 10. Annual pink salmon catches (1,000's of fish) in British Columbia, 1967 - 70, by combinations of statistical areas. Source: British Columbia catch statistics.

	Areas					Total
	1 + 2	3 + 4	5-10,30	11-21, 28,29	22-27	
1967	115	942	483	6,966	1,312	9,818
1968	1,685	1,658	12,371	3,720	203	19,637
1969	80	571	280	1,214	426	2,571
1970	1,261	1,623	7,966	2,441	309	13,600

Table 11. Annual chum salmon catches (1,000's of fish) in British Columbia, 1967 - 70, by combinations of statistical areas. Source: British Columbia catch statistics.

	Areas					
	1 + 2	3 + 4	5-10,30	11-18, 28,29	19-27	Total
1967	457	142	308	199	22	1,127
1968	661	282	1,234	873	31	3,081
1969	141	84	441	620	25	1,311
1970	590	219	1,675	1,032	163	3,679

Table 12. Estimated escapements, returns (1,000's of fish) and number returning per spawner for chum salmon in the "Johnstone Strait Study Area". The figures for 1960, 1961 and 1962 have been revised from those shown in INPFC Doc. 997, Table 12. Source: Fraser, F. J. 1971. The 1971 report on chum salmon stocks of the Johnstone Strait - Fraser River Study Area, and prospects for 1971. Canada Dept. of Fish. and For. Tech. Rept. 1971-9, 21 p.

	Spawning escapement	Return	Fish returning per spawner
1960	736	1,585	2.15
1961	643	472	0.73
1962	718	1,004	1.40
1963	706	741	0.67
1964	909	2,714	2.99
1965	401	1,404	3.50
1966	966	2,757	2.85

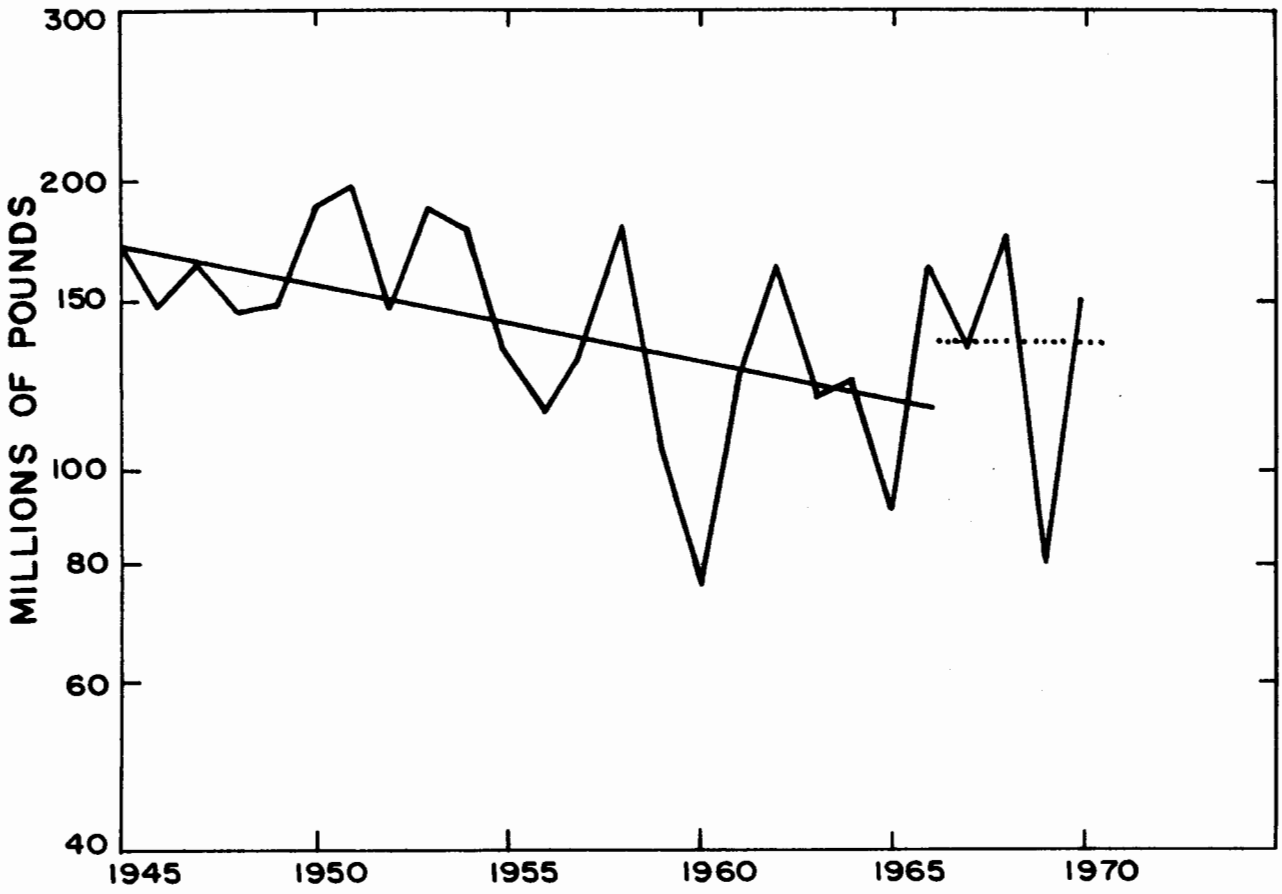

Fig. 1. Total landings of salmon in British Columbia, 1945-70 (logarithmic presentation).

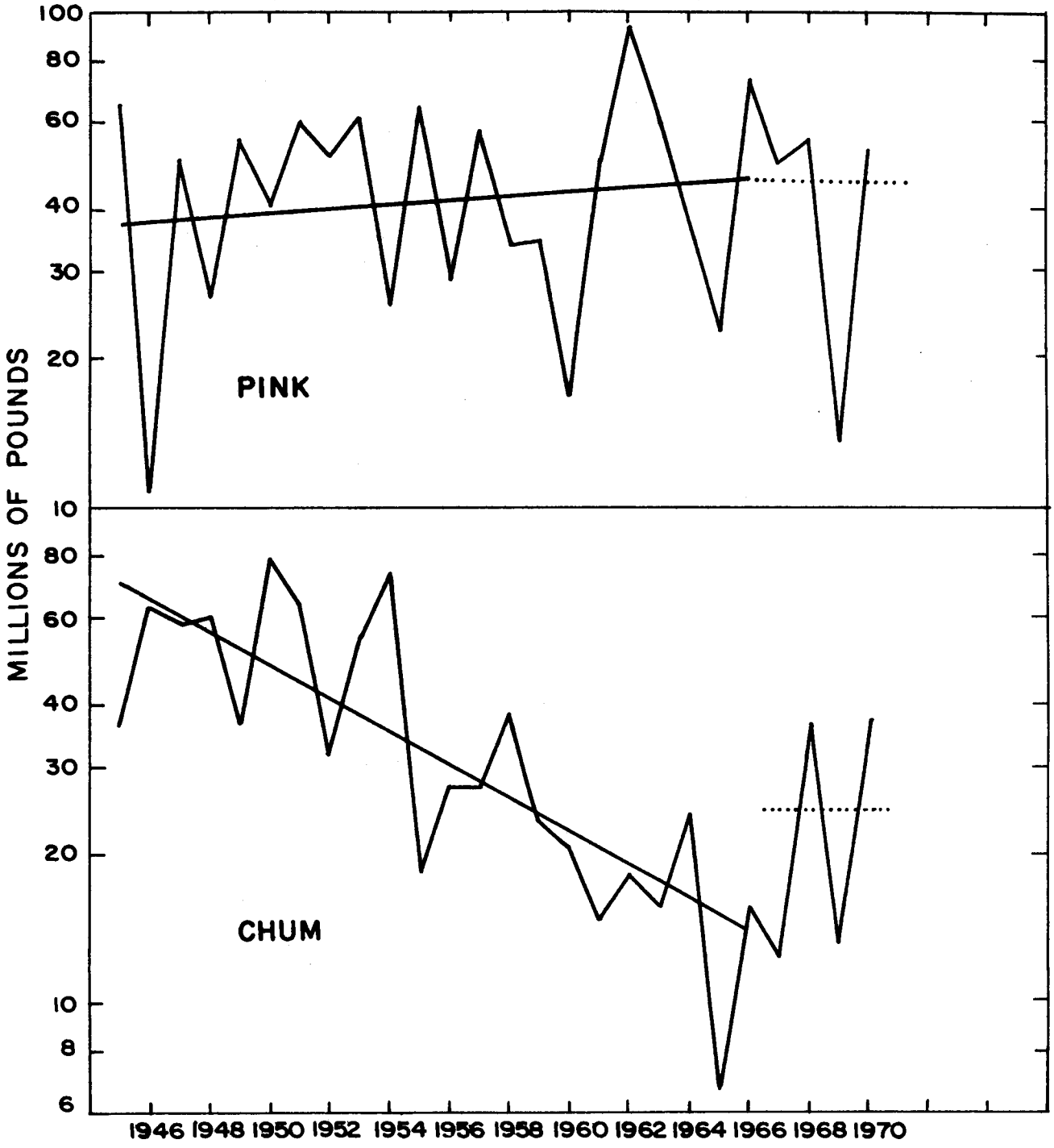

Fig. 2. British Columbia landings of pink and chum salmon, 1945-70 (logarithmic presentation).

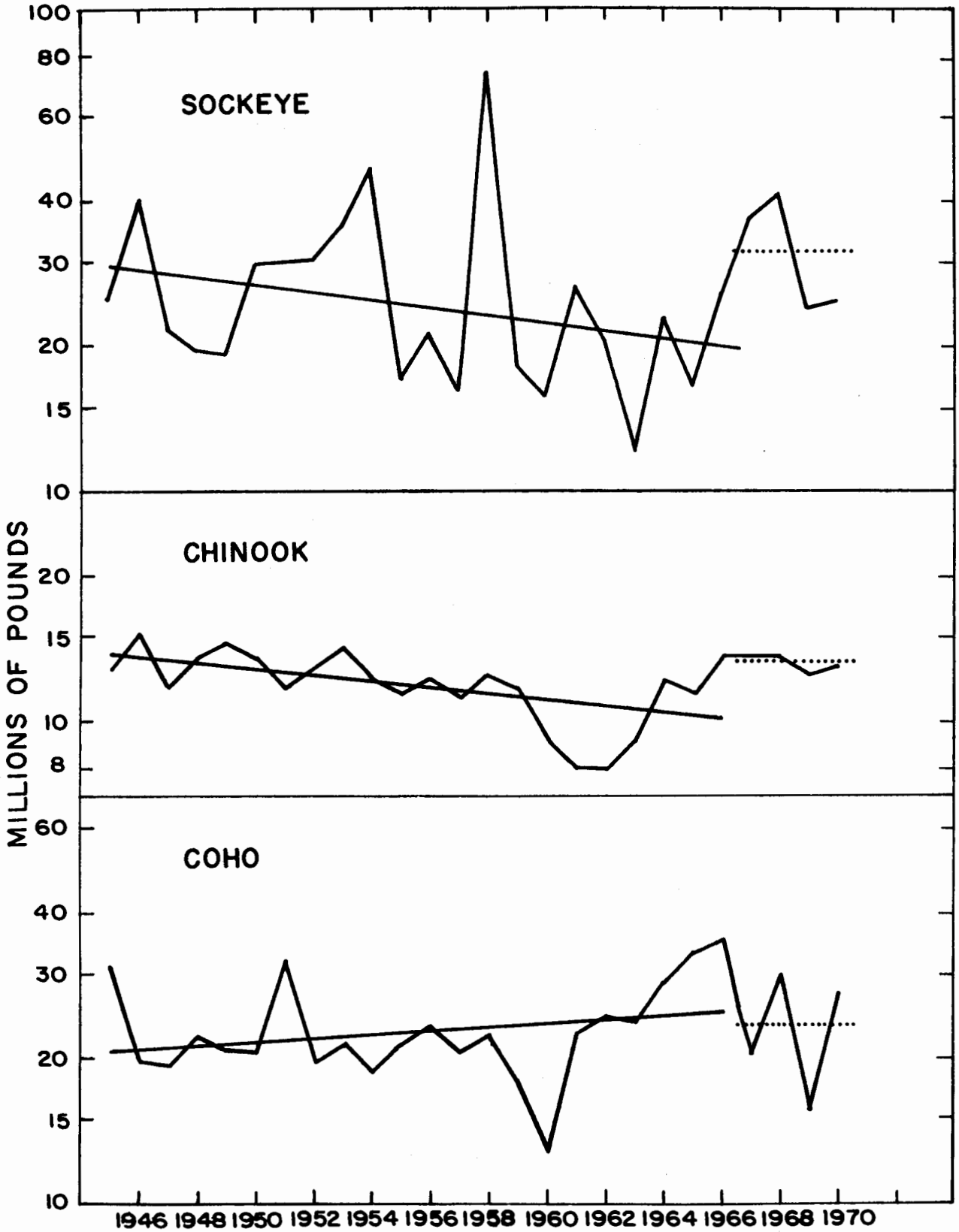

Fig. 3. British Columbia landings of sockeye, chinook and coho salmon, 1945-70 (logarithmic presentation)

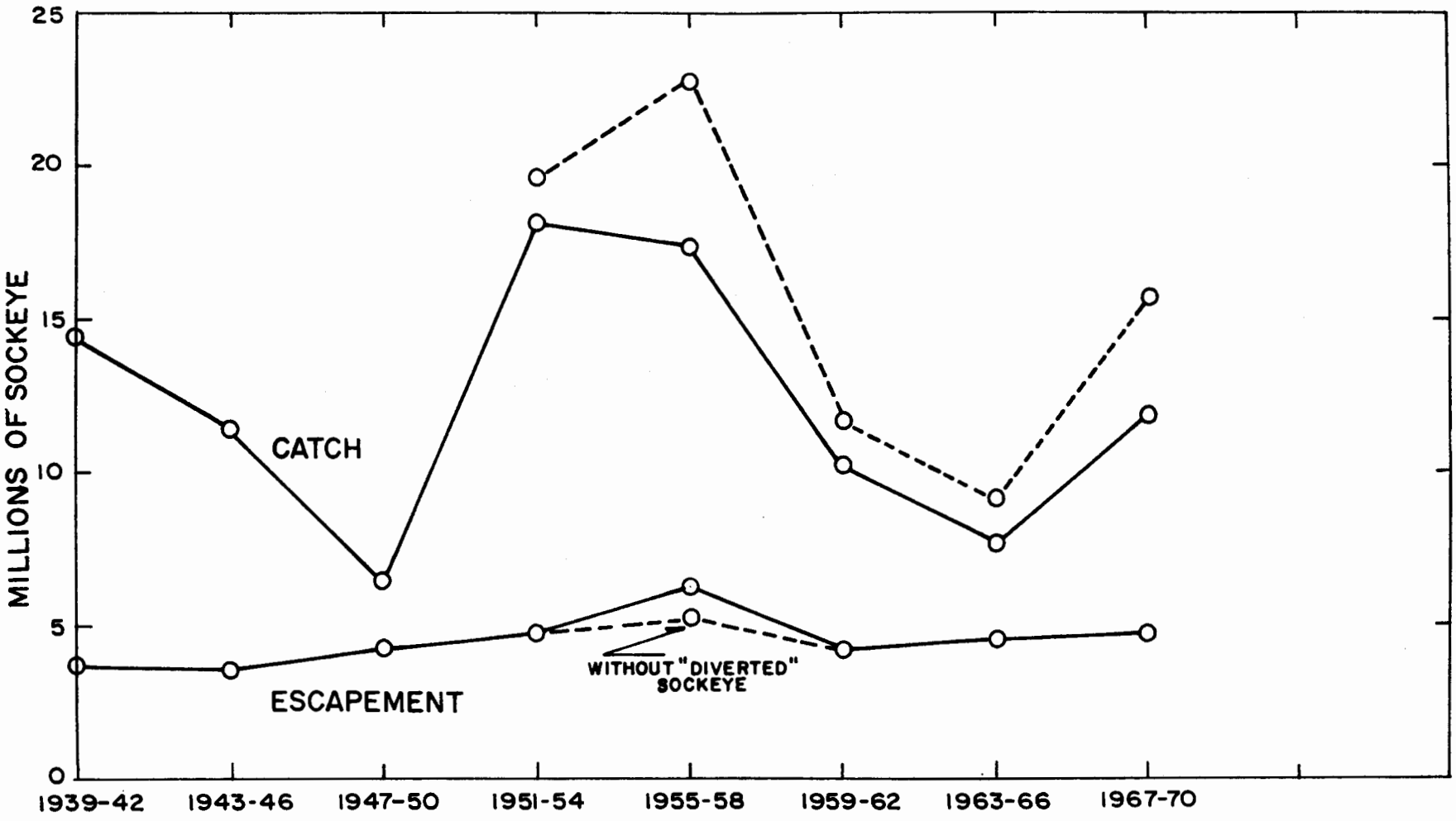

Fig. 4. Fraser River sockeye catches and escapements, by groups of four years. The solid catch line includes the catches in the Convention Area only, the broken line the catches in the Convention Area, in British Columbia statistical areas 12 to 16, and by the troll fishery along the west coast of Vancouver Island north of the Convention Area.

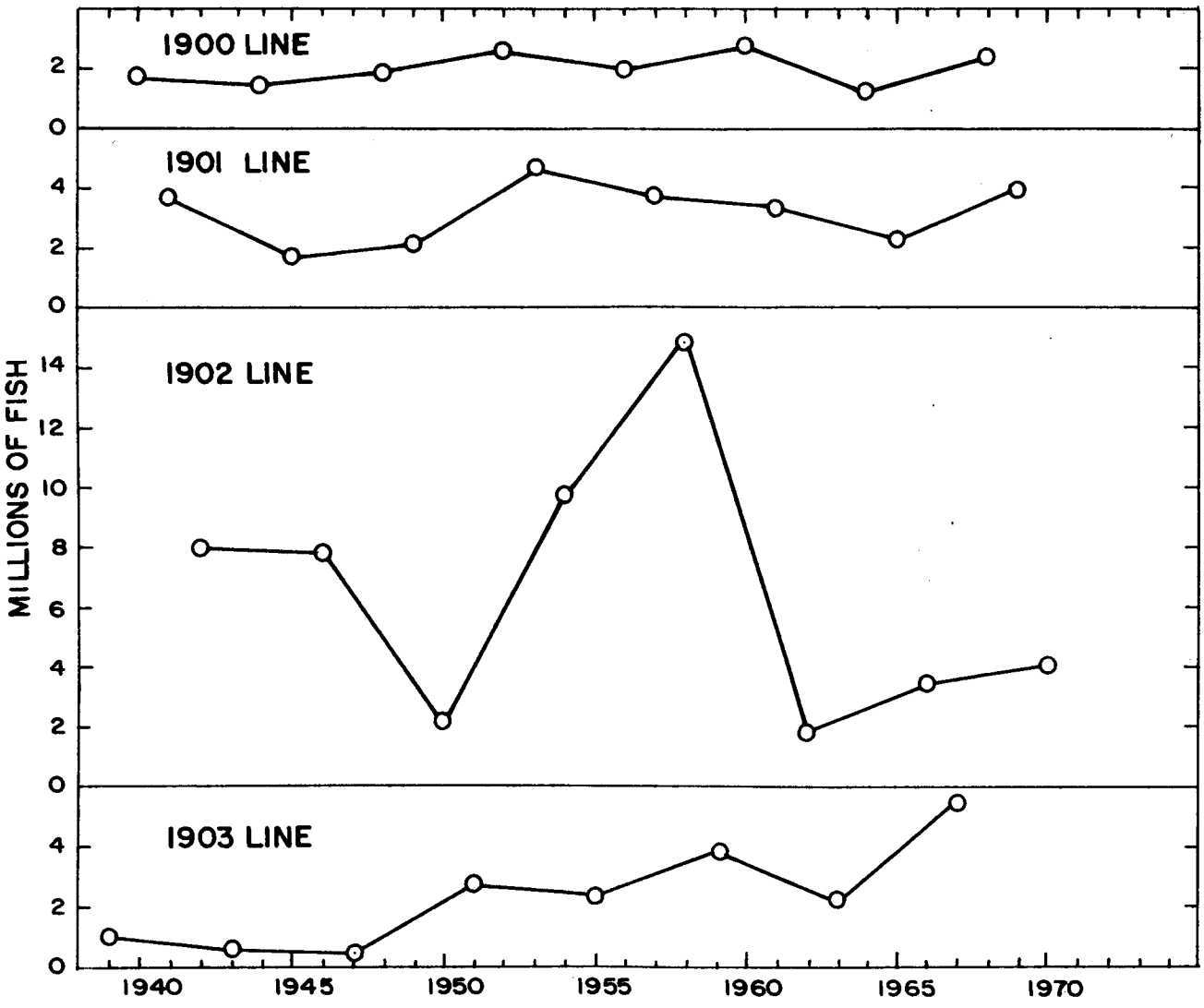

Fig. 5. Fraser River sockeye catches, 1939-70, plotted by individual "lines" within 4-year cycles.

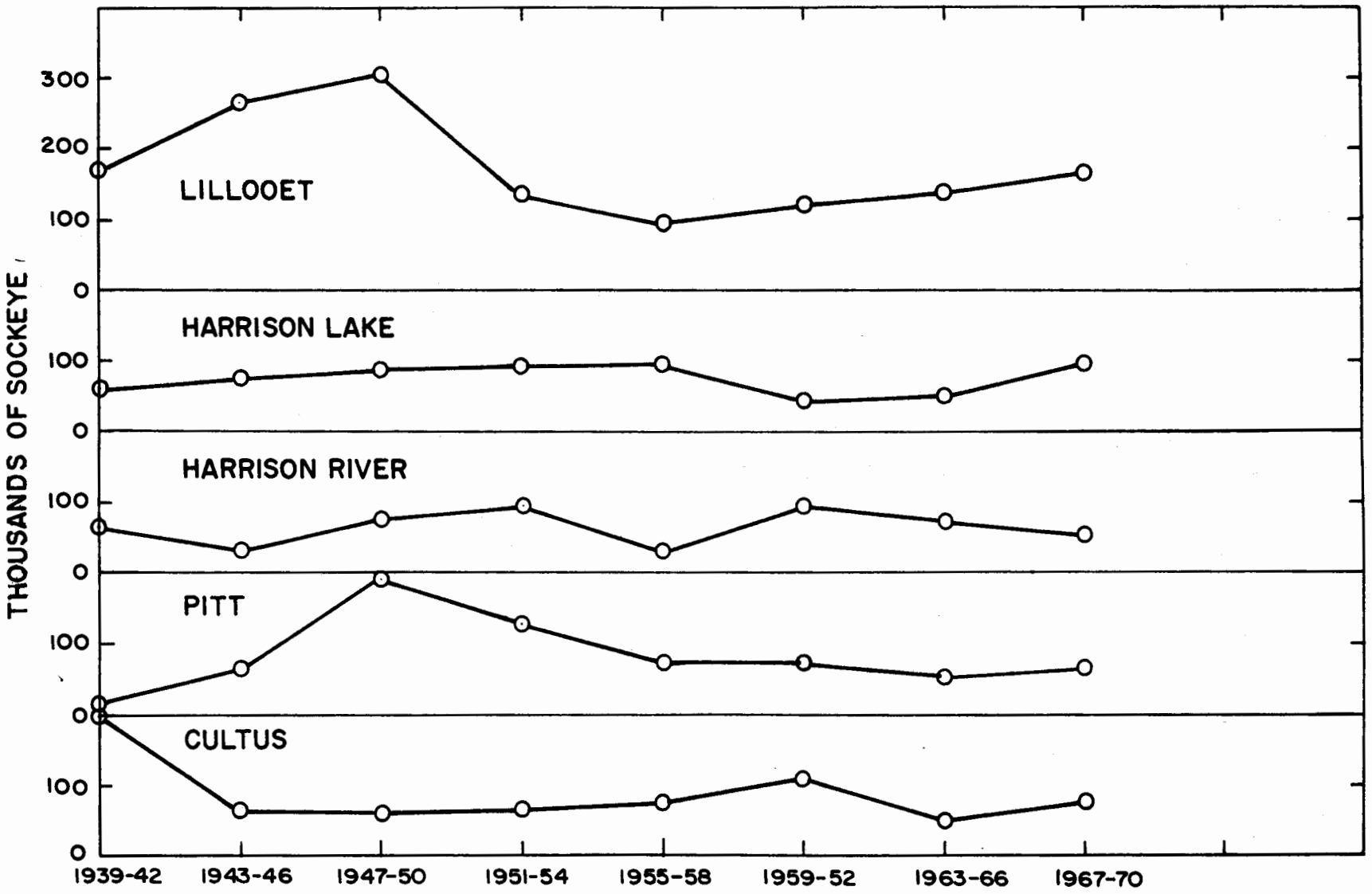

Fig. 6. Escapements of sockeye salmon (not including jacks) to lower Fraser River spawning areas. Data from Table 4.

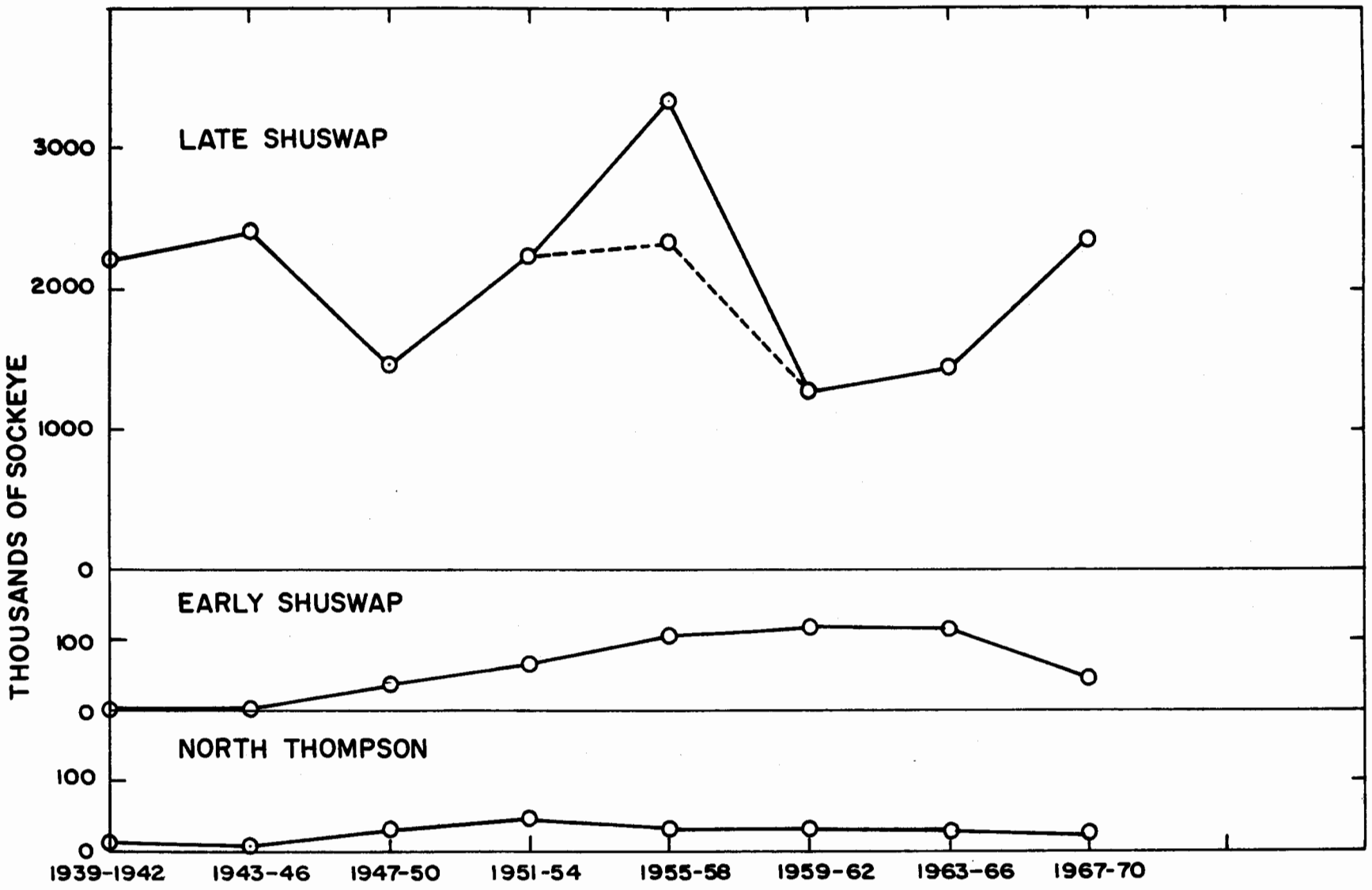

Fig. 7. Escapements of sockeye salmon (not including jacks) to Thompson River spawning areas. Data from Table 4.

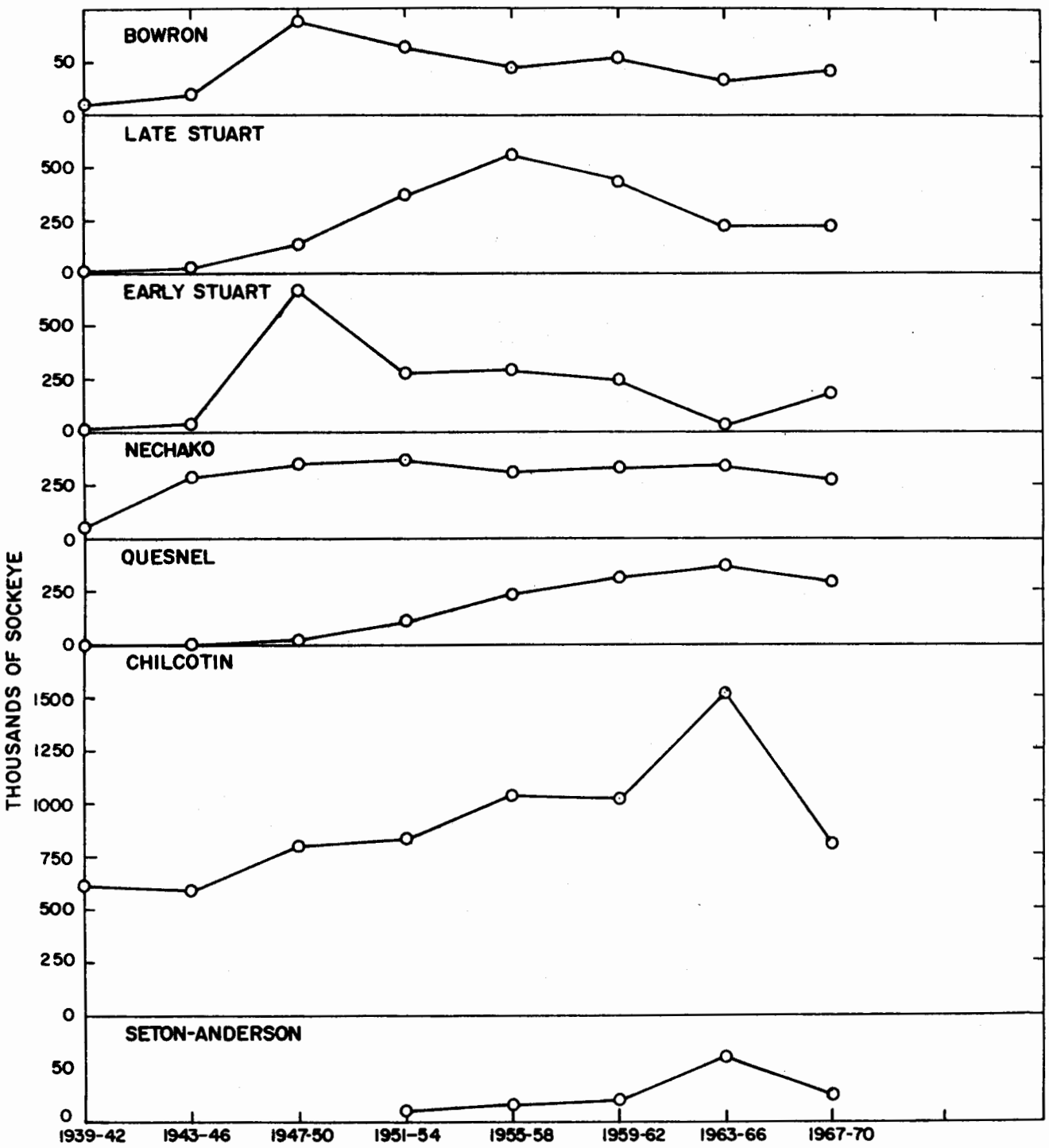

Fig. 8. Escapements of sockeye salmon (not including jacks) to spawning areas of the Fraser River above Lytton. Data from Table 4.

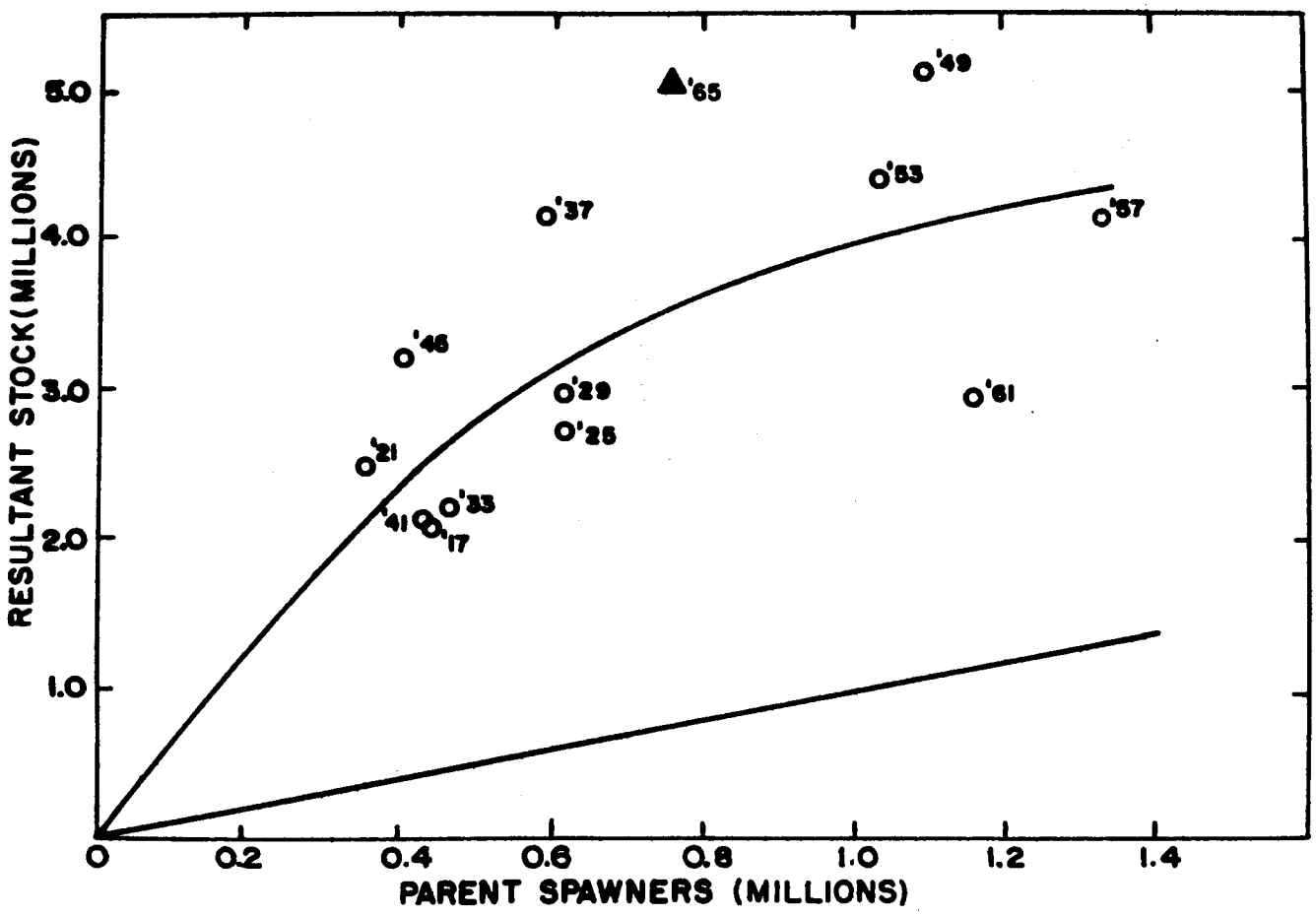

Fig. 9. Relation between escapement and return for Fraser sockeye of the 1901 line.

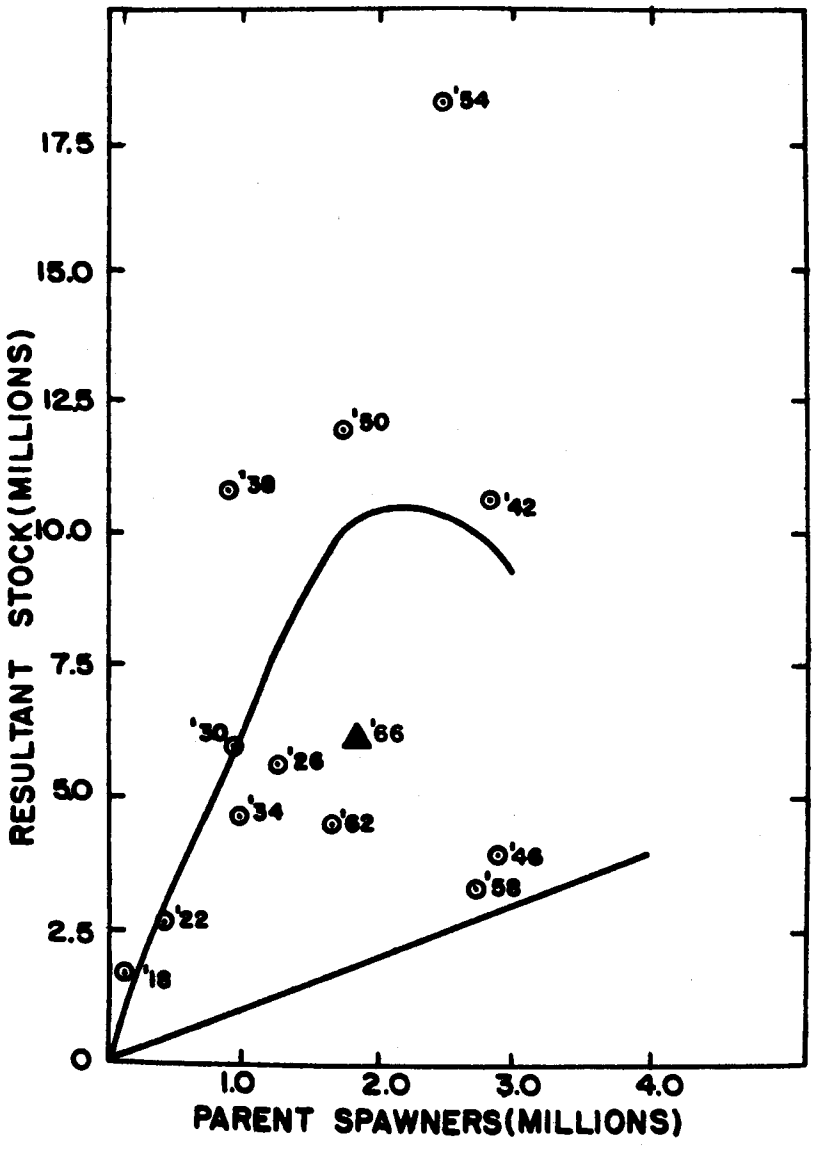

Fig. 10. Relation between escapement and return for Fraser sockeye of the 1902 line.

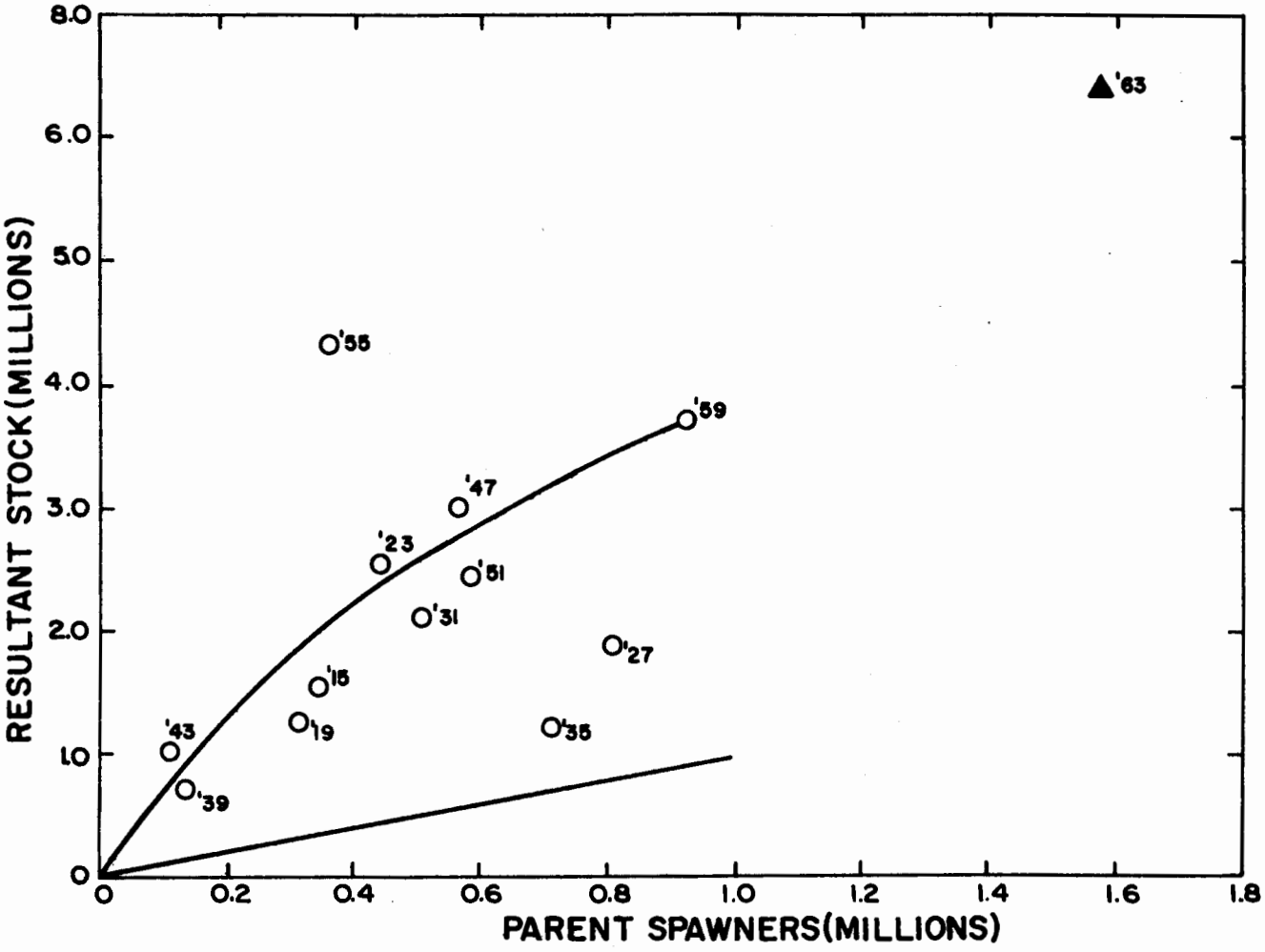

Fig. 11. Relation between escapement and return for Fraser sockeye of the 1903 line.

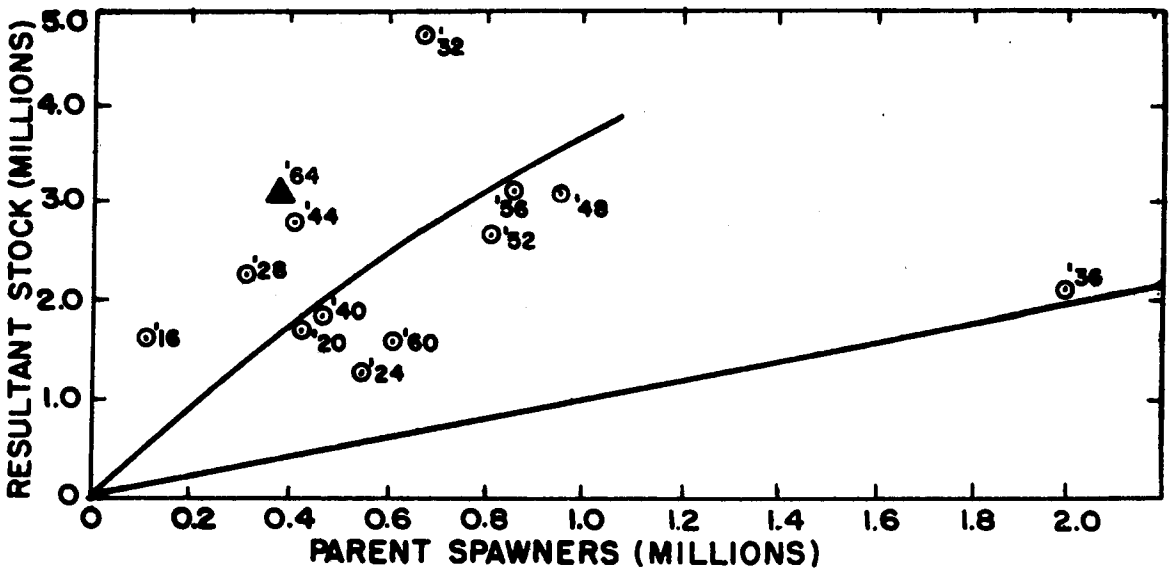

Fig. 12. Relation between escapement and return for Fraser sockeye of the 1904 line.

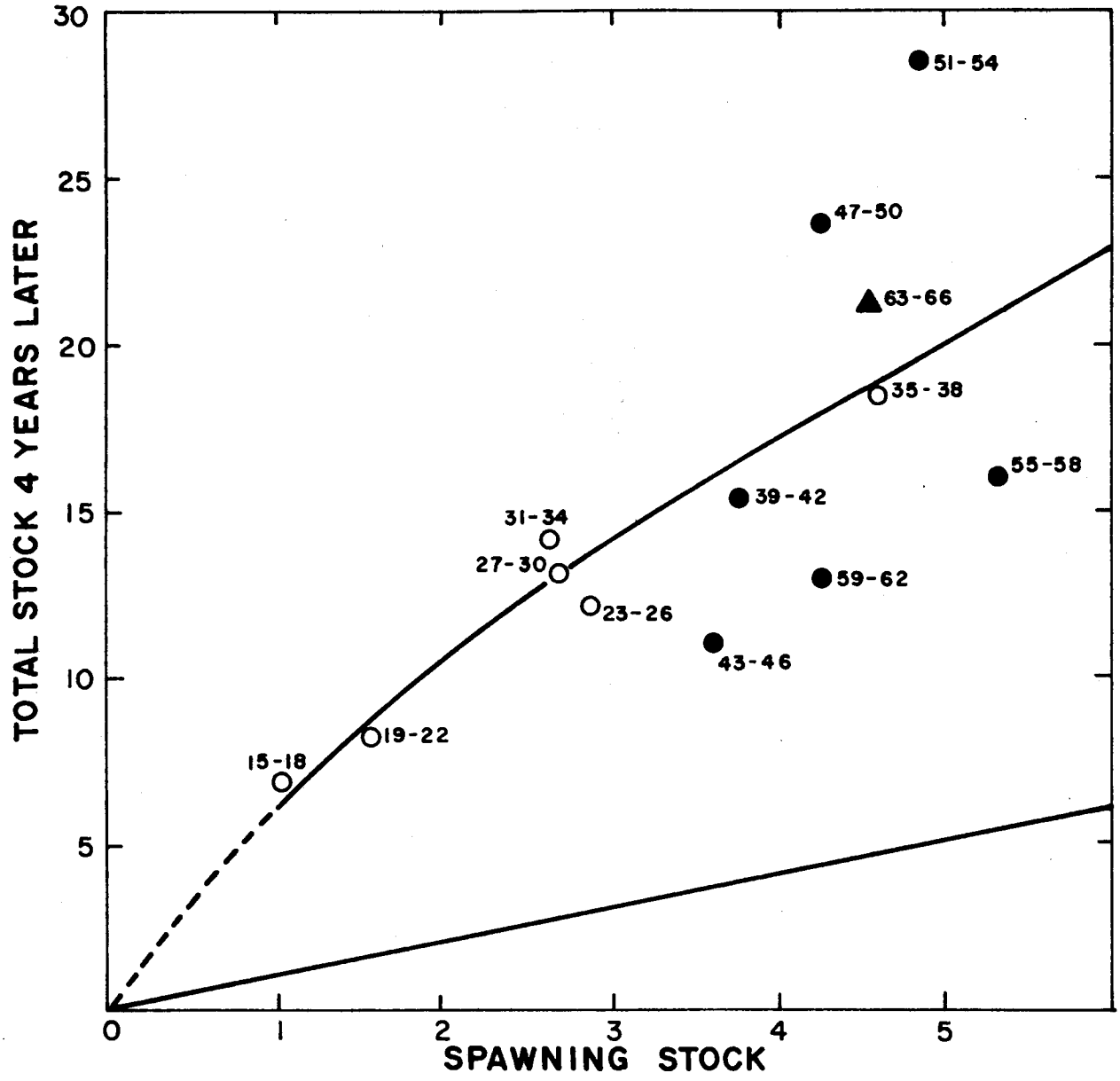

Fig. 13. Relation of estimates of spawners to total return for Fraser River sockeye, totalled by 4-year intervals, in millions of fish. Total stock includes commercial catch, subsistence catch (1939 onward) and spawning escapement (except jacks). Numbers by each point indicate the range of years included in the spawning escapement. (In 1958 the 1.0 million "diverted" sockeye are excluded from the spawning estimate, while the 4.3 million northern fish are included in the catch. 1963-66 includes catches in British Columbia statistical areas 12 to 16 and by the troll fishery along the west coast of Vancouver Island north of the Convention Area). Source: Open circles are from Rounsefell (1949, p. 120); black dots from Table 3 of INPFC Doc. 997; triangle from Table 2.

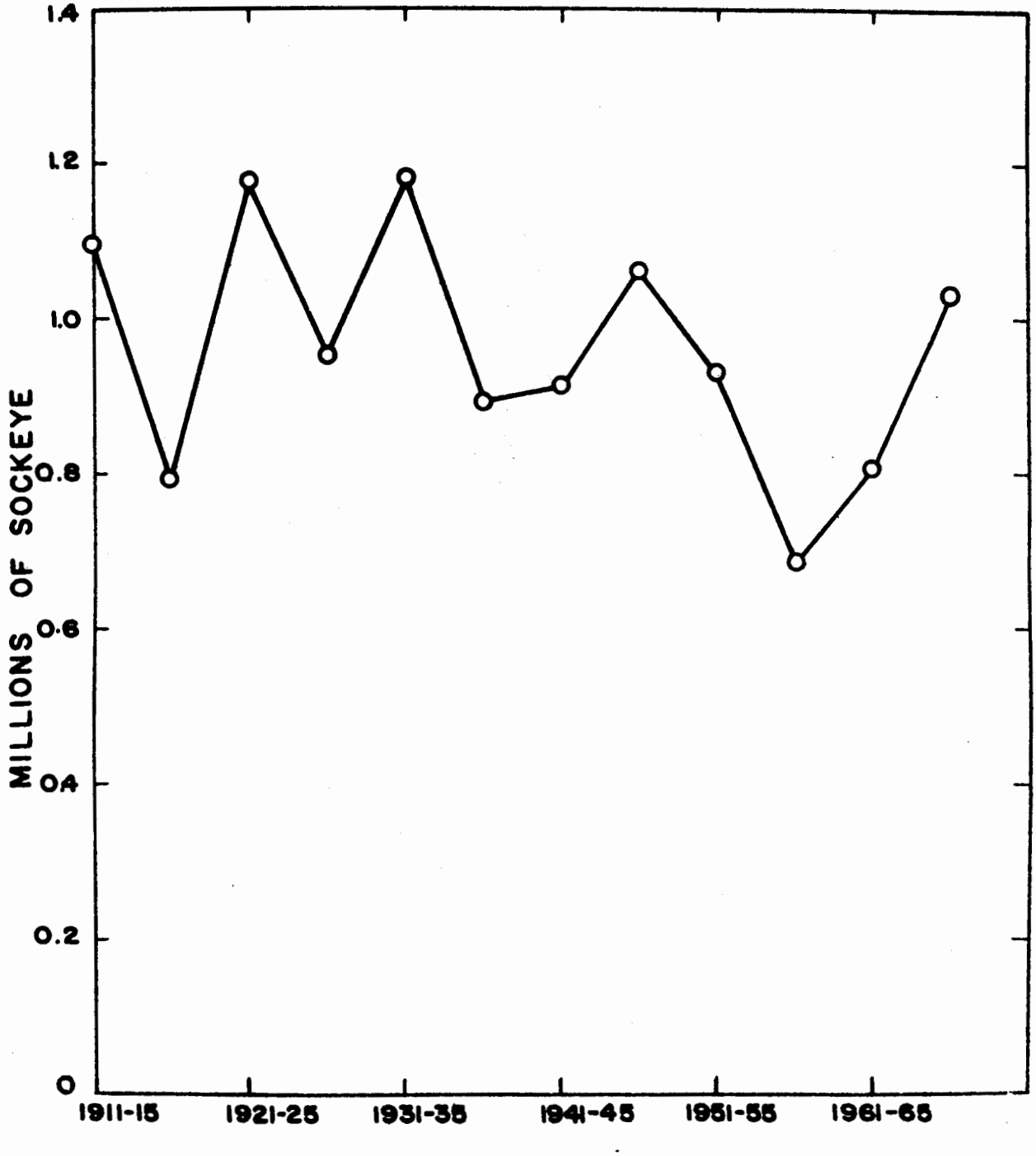

Fig. 14. Rivers Inlet sockeye catches, averaged by 5-year intervals, in numbers of fish.

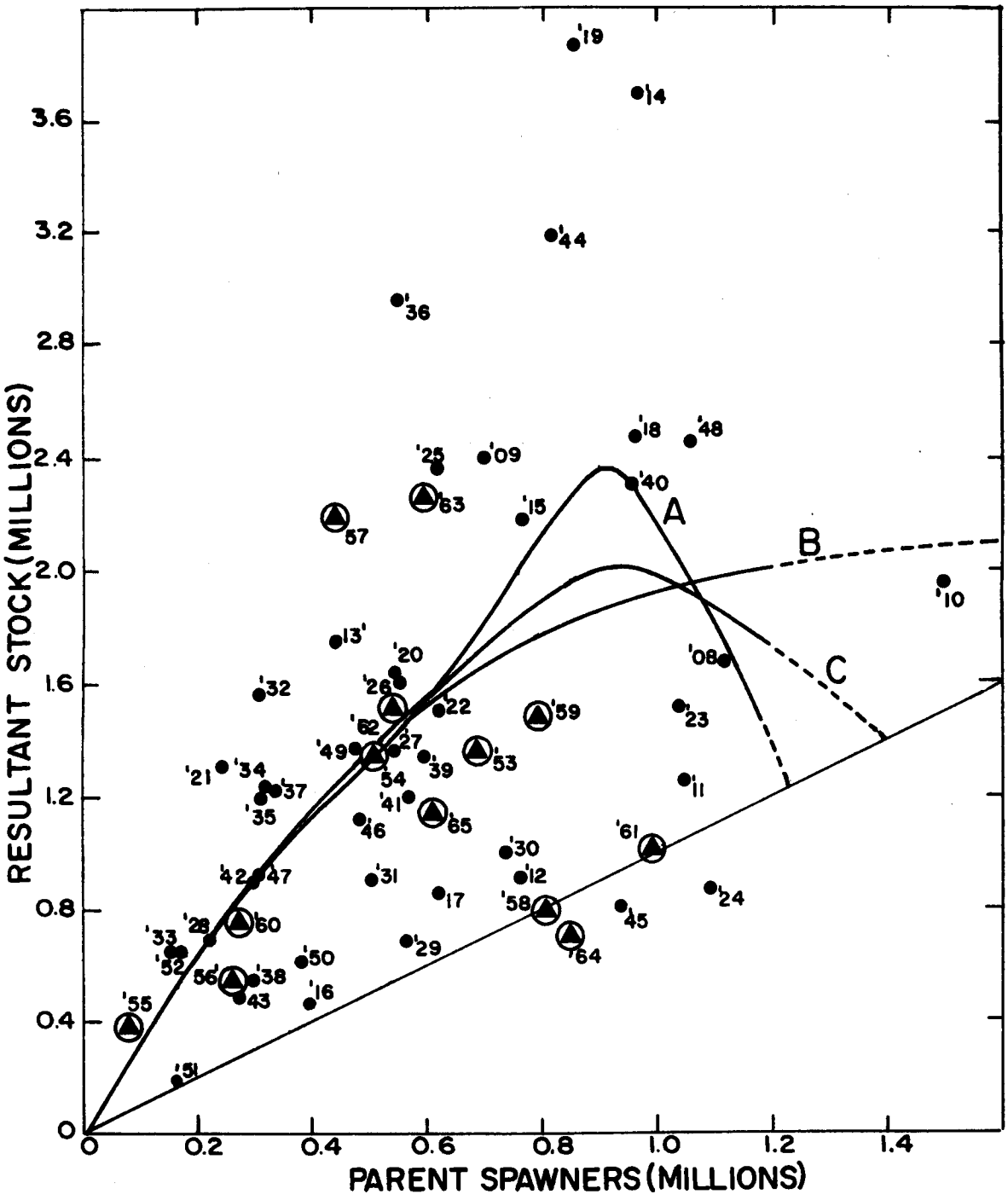

Fig. 15. Numbers of 4_2 and 5_2 Skeena sockeye (catch plus escapement) plotted against numbers of parent spawners. Figures in the body of the graph indicate brood years. Encircled points represent recent escapement-return values. Trend line A is the one drawn by Shepard and Withler (1958) on the basis of data through brood year 1952 (points without circles). Lines B and C are based on all the points shown, drawn to correspond as closely as possible to successive 5-year simple averages of the data when arranged in order of increasing numbers of spawners. Of the two latter lines, curve C is closer to the actual data; curve B represents a possible position if an abrupt decrease in reproduction above 0.9 million spawners be regarded as unlikely.

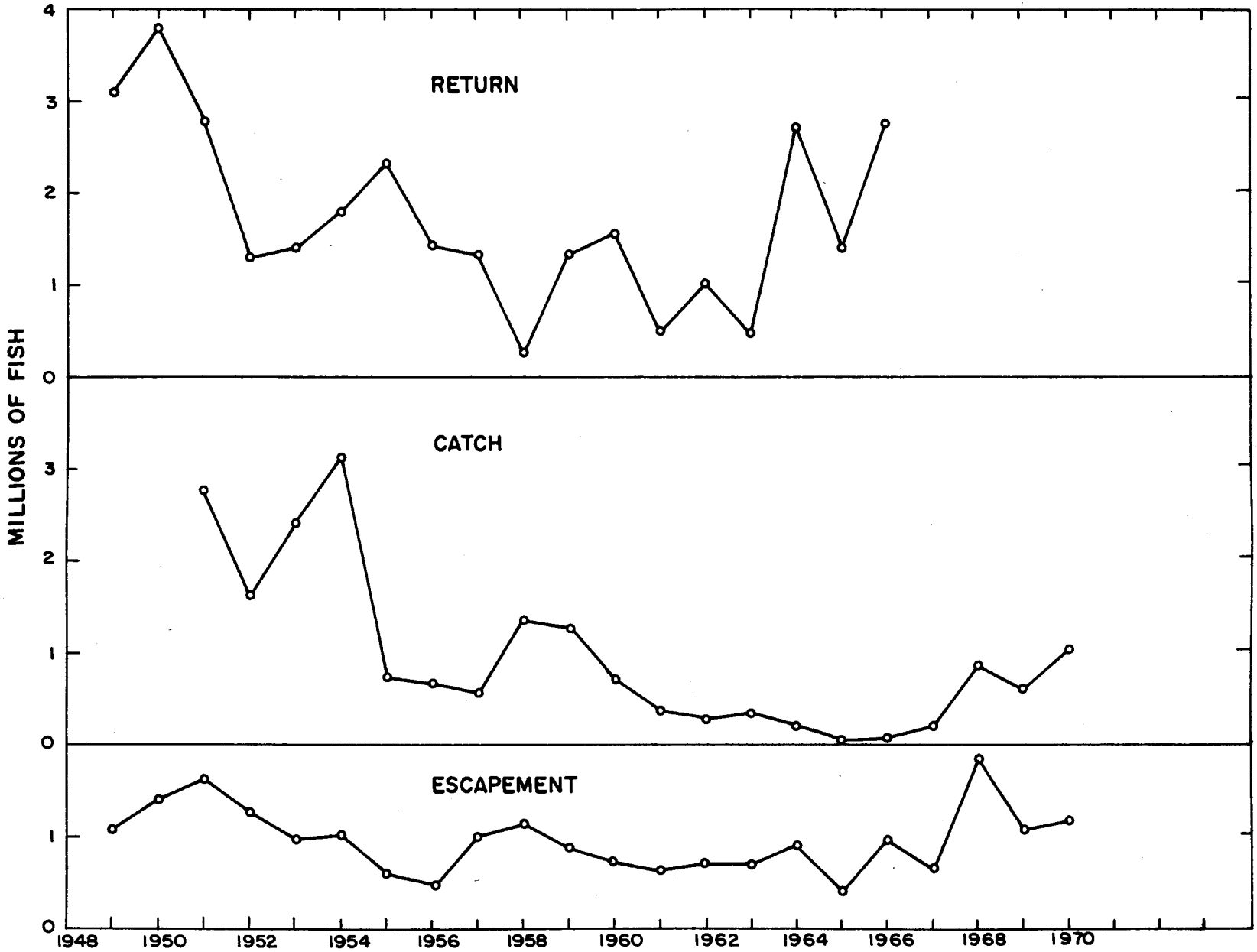

Fig. 16. Chum salmon catches and estimates of spawners through 1970, and the estimated return (catch plus estimated escapement) from the spawnings of 1949-66 for Areas 11-18, 28, 29. The returns joined by broken lines are estimated from the average age composition of the catch. Data from Table 12.

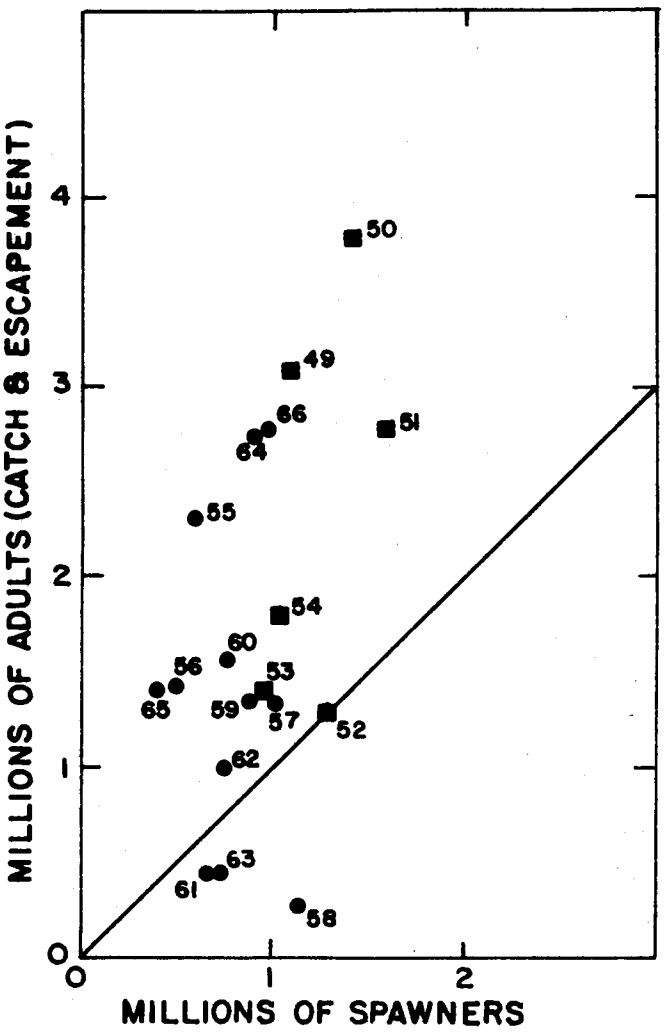

Fig. 17. Returns of chum salmon in the Johnstone Strait study area (catch plus estimated escapement) plotted against estimates of spawning stocks.